

REMARKS

The Official Action dated February 4, 2003 has been carefully considered. Accordingly, the changes presented herewith, taken with the following remarks, are believed sufficient to place the present application in condition for allowance. Reconsideration is respectfully requested.

By the present amendment, claim 1 has been amended to include limitations from claim 3, and claim 3 has been cancelled. Claim 2 has been amended for a matter of form. It is believed that these changes do not involve any introduction of new matter, and do not raise any new issues subsequent to final rejection, whereby entry is believed to be in order and is respectfully requested.

In the Official Action, claims 1-3, 6, 8-12 and 14-29 were rejected as being obvious and unpatentable over the Kaneda et al U.S. Patent No. 6,223,429 and WO 96/42107 in view of the Sugio et al U.S. Patent No. 4,503,186. The Examiner asserted that Kaneda et al teach an anisotropic conductive adhesive film adhering a semiconductor to a substrate and comprising thermoplastic or thermosetting resin, or a mixture thereof, and conductive particles. The Examiner relied on Sugio et al as teaching an adhesive composition comprising cyclic structure-containing polymers such as polyphenylene ether resins suitable for electronics. The Examiner concluded that it would have been obvious to use the polymer material taught by Sugio et al in the adhesive composition of Kaneda et al.

However, as will be set forth in detail below, Applicant submits that the anisotropic electrically conductive adhesive for semiconductor parts, adhesive films, semiconductor part packages and processes defined by claims 1, 2, 6, 8-12 and 14-29 are nonobvious over and patentably distinguishable from the combination of Kaneda et al and Sugio et al.

Accordingly, this rejection is traversed, and reconsideration is respectfully requested.

More particularly, as defined by independent Claim 1, the present invention is directed to an anisotropic electrically conductive adhesive for semiconductor parts. The adhesive comprises a cyclic structure-containing thermoplastic polymer selected from the group consisting of (a) a cycloolefin polymer and (b) an aromatic-condensed polymer having a repeating unit of an aromatic ring in its main chain, and having a number average molecular weight of 1,000 to 500,000, and an electrically conductive filler. The adhesive has anisotropic electrical conductivity and the cyclic structure-containing thermoplastic polymer has a functional group selected from the group consisting of an alcohol group, epoxy group, carboxyl group, acid anhydride group and silanol group.

Claim 16 is directed to an adhesive film for semiconductor parts formed from the adhesive, while claim 17 is directed to a semiconductor part package obtained by bonding a semiconductor part to a substrate with a solution or film of the adhesive. Claims 18 and 20 are directed to processes for producing a semiconductor part package, which processes comprise laminating an adhesive film obtained by forming a film from the anisotropic conductive adhesive of claim 1. Claims 19 and 21 are directed to processes for producing a semiconductor part package, which processes comprise, inter alia, applying a solution of the anisotropic conductive adhesive of claim 1.

The adhesives according to the present invention are excellent in electrical properties such as dielectric constant and dielectric loss tangent, and moisture resistance, and moreover exhibit excellent adhesive properties to semiconductor chips, packaging boards and the like.

When using the anisotropic conductive adhesive for semiconductor parts according to the invention, the conductive filler dispersed in the cyclic structure-containing thermoplastic polymer is present on connection terminals, and the conductive filler is squeezed from point contact to a state close to face contact by applying heat and pressure, thereby producing conductivity and at the same time fully bonding a semiconductor part to a substrate to

achieve stable bonding. Importantly, lateral insulation properties are achieved, while maintaining conductivity between upper and lower terminals, by controlling the amount of the conductive filler dispersed therein.

As the miniaturization and high-density packaging of electronic parts has progressed, terminal intervals have been reduced and demands for coping with the formation of fine-pitch patterns and ensuring high reliability at joints have increased. However, conventional anisotropic conductive materials typically cannot provide the formation of sufficient fine-pitch patterns. In fine-pitch patterns, for example, the width of a beam lead in a beam lead type semiconductor chip is 50 to 100 μm , and an interval between beam leads is about 50 to 100 μm . When bump bonding is conducted with conventional anisotropic conductive materials on such an electronic part in which a fine-pitch pattern has been formed, it is difficult to ensure insulating properties between bumps.

However, the anisotropic conductive adhesive according to the present invention can meet these demands because the base polymer is excellent in dielectric properties, as demonstrated in Examples 19-26 in the present specification. Thus, the anisotropic conductive adhesive according to the present invention provides electrode to electrode electrical connection while maintaining lateral electrical insulation.

Kaneda et al teach a semiconductor device and a method of producing the semiconductor device whereby an anisotropic conductive adhesive film cast from a solvent is used to adhere a semiconductor to a substrate and electrically connect opposing electrodes by heating and pressurizing the adhesive film therebetween (column 5, lines 1-29). Kaneda et al teach that the anisotropic conductive adhesive comprises an insulating thermoplastic resin, thermosetting resin, or mixture of both, and conductive particles in an amount preferably of 0.1 to 30% by volume with respect to the matrix resin material in order to ensure anisotropic conductivity (column 6, lines 31-47).

However, Kaneda et al do not teach that the matrix resin is a cyclic-structure-containing polymer as instantly claimed. More particularly, Kaneda et al neither teach nor suggest that the matrix resin is a cyclic structure-containing thermoplastic polymer having a functional group selected from the group consisting of an alcohol group, epoxy group, carboxyl group, acid anhydride group and silanol group. At column 5, Kaneda et al discuss suitable insulating matrix resins for the anisotropic adhesive. In addition to epoxy resin and phenoxy resin, Kaneda et al disclose polyester, polyvinyl butyral, and polyimide resins or a composite mixture of thermoplastic resin and thermosetting resin. Epoxy resin is discussed in further detail, beginning at line 33.

Examples 1-5 of Kaneda et al employ AC8301 available from Hitachi Chemical Company, Ltd. Although the resin of this adhesive is not disclosed, Kaneda et al indicate that the anisotropic conductive adhesive film AC8301 has a double-layer structure (column 11, lines 58-60). Kaneda et al teach that a film having a double-layer structure comprises a matrix resin layer and a layer of matrix resin with conductive particles dispersed therein (column 6, line 67 - column 7, line 4). Hitachi Chemical's Technical Report No. 33 (1999-7) attached hereto as reference document 1 refers to the anisotropic conductive films of the Anisorm AC-8000 Series manufactured and sold by Hitachi Chemical Co., Ltd. Applicant advises that, as illustrated therein, the anisotropic conductive films of the AC-8000 Series have a double-layer structure. Such structures use an epoxy adhesive agent.

In Example 6, Kaneda et al employ an anisotropic conductive adhesive film comprising phenoxy resin, acrylic rubber and liquid epoxy resin containing a microcapsule type latent curing agent. JP-A 8-199191 is attached hereto as reference document 2, and Applicant advises that this document discloses a similar anisotropic conductive film Anisorm AC-7073 sold from Hitachi Chemical Co., Ltd., and composed mainly of an epoxy adhesive agent containing an imidazole catalyst type curing agent, with a thickness of 25 mm.

The anisotropic electrically conductive adhesive of claim 1 comprising a cyclic structure-containing thermoplastic polymer selected from the group consisting of a cycloolefin polymer and an aromatic-containing polymer having a repeating unit of an aromatic ring in its main chain and a functional group selected from the recited group provides improvement over epoxy resins conventionally employed in the art and taught by Kaneda et al. The Examiner's attention is directed to the background discussion in the specification at pages 6 and 7 and to the showings set forth in Table 3, particularly a comparison of Examples 19-26 with Comparative Examples 4-6. These comparative examples are representative of the exemplary examples of Kaneda et al as they employ epoxy resins, and the adhesives of these comparative examples exhibited unacceptable increases in connection resistance upon exposure to high heat and humidity conditions. On the other hand, the adhesives of Examples 19-26 according to the invention exhibited stable performance, even after exposure to high heat and humidity conditions. Kaneda et al provide no teaching, suggestion or recognition that such improvements can be provided by an adhesive containing a thermoplastic polymer as presently claimed.

Sugio et al teach an adhesive composition comprising polyphenylene ether resins, which have excellent adhesiveness to metals such as copper, have excellent resistance to heat, solvent and moisture, and are suitable for electronics with high performance (Abstract; column 2, lines 30-40). The polyphenylene ether resin may be a grafted copolymer in which unsaturated monomer is grafted on the polyphenylene polymer or copolymer (column 4, lines 35-55). However, Sugio et al merely disclose graft copolymers in which polystyrene is grafted on the polymer or copolymer, and Sugio et al neither teach nor suggest polyphenylene ether resins having a functional group selected from an alcohol group, epoxy group, carboxyl group, acid anhydride group and silanol group.

Sugio et al disclose that reinforcing materials or fillers in fibrous or powdery form may be incorporated in the curable resin composition (Col. 10, lines 36-44). However, Applicants find no disclosure in Sugio et al relating to an electrically conductive filler. Sugio et al neither teach nor suggest an anisotropic electrically conductive adhesive.

While Sugio et al describe a composition containing a polyphenylene ether resin, Applicant finds no teaching or suggestion in Sugio et al for substituting their respective resin for the epoxy resin taught by Kaneda et al. Moreover, a polyphenylene ether resin having no functional group as presently claimed can not exhibit the excellent adhesive property as compared with the present functional group-containing polymer.

References relied upon to support a rejection under 35 U.S.C. §103 must provide an enabling disclosure, i.e., they must place the claimed invention in the possession of the public, *In re Payne*, 203 U.S.P.Q. 245 (CCPA 1979). In view of the failure of Kaneda et al and Sugio et al to teach an adhesive comprising a polymer as presently claimed, or the improvements exhibited thereby and as demonstrated in the present examples and comparative examples, the combination of Kaneda et al and Sugio et al does not provide an enabling disclosure of the present invention and therefore does not render the present invention obvious.

It is therefore submitted that the adhesives, films, semiconductor part packages and processes defined by claims 1, 2, 6, 8-12 and 14-29 are not rendered obvious over Kaneda et al in view of Sugio et al, whereby the rejection under 35 U.S.C. § 103 has been overcome. Reconsideration is respectfully requested.

In the Official Action, claims 1-5, 8-12 and 15-29 were rejected as being obvious and unpatentable over Kaneda et al in view of the Kataoka et al U.S. Patent No. 5,783,639. The Examiner relied on Kataoka et al as teaching an insulating resin composition comprising an epoxy group-containing cycloolefin resin useful in the field of electronics. The Examiner

concluded that it would have been obvious to use the resin of Kataoka et al in the adhesive of Kaneda et al.

However, as will be set forth in detail below, Applicants submit that the anisotropic electrically conductive adhesive for semiconductor parts, adhesive films, semiconductor part packages and processes defined by claims 1, 2, 4, 5, 8-12 and 15-29 are nonobvious over and patentably distinguishable from the combination of Kaneda et al and Kataoka et al.

Accordingly, this rejection is traversed, and reconsideration is respectfully requested.

The adhesives, films, semiconductor part packages and processes defined by the present claims are discussed in detail above. Importantly, the adhesives according to the present invention are anisotropic electrically conductive and comprise the cyclic structure-containing thermoplastic polymer having the functional group and electrically conductive filler. The deficiencies of Kaneda et al are also discussed above. Namely, Kaneda et al do not teach or suggest an adhesive comprising a polymer as presently claimed, or the improvements exhibited thereby.

Kataoka et al disclose a resin composition comprising an epoxy group-containing cycloolefin resin and a crosslinking agent. However, the resin composition is suitable for use as an insulating material. Applicants find no teaching or suggestion by Kataoka et al relating to an adhesive which is anisotropic electrically conductive.

Anisotropic conductive adhesives or anisotropic conductive adhesive films should be excellent in adhesion to not only substrate-forming insulating materials but interconnections (bumps) of conductor circuits and devices as well. In addition, these anisotropic conductive adhesives or films must be improved in adhesion to different types of materials such as insulating materials or sealing agents laminated thereon. Even with a resin that possesses adhesion in itself, its adhesion often drops once it is filled with an anisotropic conductive filler. However, Kataoka et al provide no teaching or suggestion for one skilled in the art to

use their insulating material in an anisotropic conductive adhesive, or regarding any application in which the resin itself may be used as an adhesive.

The mere fact that the prior art could be modified to result in an invention would not have made the modification obvious unless the prior art suggested the desirability of the modification, *In re Mills*, 16 USPQ2d 1430 (Fed. Cir. 1990). Applicant finds no such suggestion of desirability for any combination of Kaneda et al and Kataoka et al. Thus, the combination of Kaneda et al and Kataoka et al does not suggest the present anisotropic electrically conductive adhesive, or the improvements provided thereby.

It is therefore submitted that the adhesives, films, semiconductor part packages and processes defined by claims 1, 2, 4, 5, 8-12 and 15-29 are non-obvious over Kaneda et al in view of Kataoka et al, whereby the rejection under 35 U.S.C. § 103 has been overcome. Reconsideration is respectfully requested.

It is believed that the above represents a complete response to the rejections under 35 U.S.C. §103, and places the present application in condition for allowance. Reconsideration and an early allowance are requested.

Respectfully submitted,

By 

Holly D. Kozlowski, Reg. No. 30,468
Attorney for Applicants
DINSMORE & SHOHL LLP
1900 Chemed Center
255 East Fifth Street
Cincinnati, Ohio 45202
(513) 977-8568

928778v1